

RODENT RESEARCH IN INDIA

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I take justifiable pride in the fact that all through my teaching/research career spanning the last two decades it has almost been a habit with me to ensure that the organisation that I might be serving at any particular time must have all the available volumes of *JBNHS* in its library. While I cannot altogether disown selfish motives in being in close physical proximity to the fascinating store of nature lore that the pages of *JBNHS* contain, I can at least claim to nurture, at the same time a sustained interest in the propagation of *JBNHS* for the values that it has upheld all these 75 years. Therefore, when I received an invitation from the Editor to contribute to the 75th Anniversary Volume, I took it as an opportunity to repay my debt to this great journal at least partially. I am presenting a brief account of rodent research that has been carried out in the country during the period since the 50th Volume of *JBNHS* was published.

India's golden period of mammal research was during the early part of this century when an immense volume of material poured out of the press, written by stalwarts of Indian mammalogy. A lucid account of the history of Indian mammalogy has been presented by Kinnear (1952) in the 50th Volume of the *JBNHS*. Pertaining to rodents, probably the most important were the 55 reports of the *BNHS* Mammal Survey incorporating the Scientific Results and Summaries of the survey series, mostly done by Wroughton. After this period, a sort of dormancy prevailed in respect of research work on rodents as well as mammals

in our country which was probably broken in 1953 by Professor Daya Krishna of the Jasant College, Jodhpur, who was awarded a Research Project on Vertebrate Ecology of the Indian Desert by U.N.E.S.C.O. I had the privilege of starting it as the mammalogist. It continued upto 1956. Individually Dr. M. L. Roonwal had already started his monographic work on the mammals of Manipur (1948, 1949, 1950). Later, Indian Council of Agricultural Research (ICAR) established, in 1959, a section on Animal Ecology in the Central Arid Zone Research Institute, Jodhpur, chiefly to study the desert rodents and to find out ways and means to control them. The author has been working in this section since its inception. Simultaneously, ICAR launched a Coordinated Scheme for research on the study of field rats. It lasted till 1969. The Johns Hopkins University started a centre at Calcutta and rodent research was a part of its programme. In 1970 U.S.A.I.D. launched a field programme of rodent control in the Sidhpur taluka in Gujarat State and in 1972 the Ford Foundation funded Department of Vertebrate Biology in the University of Agricultural Sciences at Bangalore. Thereafter, ICAR again renewed its interest in Rodent Research, initiating an All India Coordinated Programme on Rodent Research with four centres and by launch-

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ing a National Programme for Rodent Pest Management in 1975. I am endeavouring to present briefly the salient features of research conducted under the above mentioned projects and a few more centres.

Central Arid zone Research Institute,
Jodhpur

Ecological Survey

An ecological survey of rodent population in a vast region representing the desert biome was conducted and besides reporting 8 rodent species for the first time, district-wise density of rodents, relative abundance, species composition in various habitats, and their inter-relationship with vegetation types, agricultural crops and soil texture have been worked out (Prakash *et al.* 1971). Certain rodent pests show habitat-specificity, such as: *Gerbillus n. indus* occurs exclusively in the sandy habitat; *Rattus c. cutchicus* and *Mus cervicolor philipsi* in the rocky habitat; and *R. meltada pallidior*, *Golunda ellioti*, *Nesokia indica*, *Mus booduga* in the agricultural crops. Our colleague, Shri Rana has just collected *Bandicota bengalensis* and *Vandeleuria o. spadicea* from Bisalpur, from the foot of Aravallis in western Rajasthan.

Food

The rodents feed throughout the year upon vegetative parts of plants, supplemented by seeds (post-monsoon and winter) and insects (spring and summer for *Tatera* and summer for *Meriones*). The fluctuations in the occurrence of various food items were more common in the latter gerbil, which were in conformity with the changing vegetational ecosystem reflecting the availability of different food items. The food preferences of merion gerbil were studied in the field during monsoon by comparing the frequency of occurrence of each plant species in the biotope with that

of the un-consumed plant species lying near burrow openings of the gerbils. It was revealed that they show a definite preference for palatable grasses, the preference being in the following order: *Cenchrus ciliaris*, *Aristida adscensionis*, *Eragrostis ciliaris*, *Digitaria adscendens*, *Brachiaria ramosa* and *Tragus biflorus*. In the desert tract where the study was conducted, the density of desert gerbils was estimated to be 477 per hectare. Considering that a gerbil consumes about 6 gm. feed a day, their annual requirement will be 1044 kg/hectare assuming that their number will be maintained at this level all the year round. The figure of the estimated forage production in this tract were 1410 per hectare. Comparing this figure it will appear that hardly any fodder will be left for livestock, particularly when the estimate of the gerbil deprecation does not include the destruction they do by cutting the grasses and by digging burrows in the root systems of plants. The gerbils do serious damage to tree plantations by their debarking activity. Sometimes the debarking is done so deep that the system is completely cut causing the death of the tree. Worst affected by the debarking activity of gerbils are *Prosopis spicigera*, *Albizia lebbek* and *Acacia tortilis*. They are extremely destructive to the afforestation saplings (Prakash 1975).

The gerbils are also serious factors of desertification as they excavate the stabilised soil at a rate of 61,500 kg/day/km.²

Breeding season

Most of the rodents breed all the year round with peak littering activity in February, monsoon season and November. Minimum breeding activity was, however, observed during April and May. These studies indicate that if rodent control is to be carried out through poison baits, the operations should be taken

up during the period of minimum breeding activity (April and May), whereas if gassing is to be followed, the period of maximum littering (monsoon season) should be chosen.

Population characteristics

Detailed studies on population have been made only on *M. hurrianae* and *F. pennanti*. The average annual number of *M. hurrianae* varied from 31 to 456 per 95 × 95 m experimental plots in three bio-climatic zones of Rajasthan desert. The fluctuations in their number also show an annual trend, numbers being lowest in summer and highest in winter and spring, the increase being attributed chiefly to the enhanced rate of reproduction after monsoon as directly influenced by the availability of green food at this time. Number of desert gerbils have a direct relationship with soil characteristics, the population being thinner in clayey and compact soils. An inverse relationship was, however, found between grass cover and population density of desert gerbils (Prakash 1976). The lowest populations of palm squirrel were observed during winter, at which time they do not breed as well. This may be the correct season for their control.

Home Ranges

The average home range of male and female *F. pennanti* was found by minimum home range method to be 0.21 ± 0.73 hectares and 0.15 ± 0.034 hectares respectively. The observed range length of adult male palm squirrel was 65.61 ± 4.80 m., for adult female 46.87 ± 5.40 m., for sub-adult male 41.71 ± 10.93 m, and for sub-adult female 43.95 ± 1.85 m. The observed range length of adult males is more than other groups probably because of higher competition among adult males for mate which are lesser in number than the former. The observed range length of male and female desert gerbil was found to be $16.03 \pm$

0.98 m and 18.46 ± 1.5 m. Work on *T. indica* is in progress. These studies have shown that the baiting stations for the control of *F. pennanti* and *M. hurrianae* should be established at an interval of 30 m and 10 m respectively.

The behavioural patterns of various rodents, *R. rattus*, *Gerbillus nanus* and *M. hurrianae* have been extensively studied. This work has clearly indicated a development of a parallel evolution of behavioural adaptations to xeric environment irrespective of geographic discontinuity in the distribution of rodent species (Prakash 1975). The study of humoral aspects has also provided pertinent and useful information regarding the timing of poisoning, bait placement and planning of the operation. Two experiments are in progress since the beginning of the project on exploratory and neophobic behaviour of rodents. The experiments are being done inside the 'plus' maze. Studies on physiological adaptations of the rodents for survival in the desert biome are incorporated in Prakash and Ghosh (1975).

Studies on the ventral marking gland are in progress. The most common use of the secretion of mid ventral gland is for marking around the entrance of burrows and for marking the trails that gerbils use to move about to many burrows. The marking frequency in adult males (median marking score: 8, range 0.27) were greater than adult female (median marking score: 0, range 0.27). Marking rate is greater in 'dominant' male gerbil than that of 'submissive' male gerbil. Efforts are being made to enhance the consumption of poison bait to increase the efficacy of control operation.

In addition to this work, bait preference of 7 species of rodents, bait shyness and lethal dosages of rodenticides for almost all the desert rodents have been worked out (Fitzwater and Prakash 1978). In this review the work on rodent control aspects has been excluded.

CAZRI has been designated as the ICAR Centre for Rodent Research and Training and is also functioning as the Coordinating Unit of the National Programme for Rodent Pest Management since it was launched during 1975 (Prakash 1976).

ICAR Coordinated Scheme on Field Rats

The Coordinated Scheme on the study of field rats, financed by ICAR, ran for 11 years (1959-69) at five centres—Kanpur, Ludhiana, Bombay, Hyderabad and Aduthurai. The major findings have been adapted from Srivastava (1968, 1969).

Species Composition

Trapping results indicated that in Uttar Pradesh, Punjab and near Madras *Bandicota bengalensis*, *Rattus melstada pallidior*, *Tatera indica* and *Nesokia indica* are the predominant field rodent species. *Rattus r. rufescens* was also reported in the coconut crops in Marutera in Andhra Pradesh. In Maharashtra, *B. bengalensis*, *R. rattus*, *Mus cervicolor nagarum* and *Bandicota indica* were found to be the major species. Probably in the absence of a set pattern of trapping it is not possible to work out the relative abundance of these species from the data. Srivastava (1968) estimated the field rat population of Uttar Pradesh fluctuating between 287 to 818 millions during various months of the year! At Rajendranagar, traps were set near coconut trees and the population of field rats varied from 3 to 8 per acre (= 7 to 19/ha) from October 67 to June 1968.

Damage assessment

Probably the best work done under the scheme was on this aspect and damages were assessed on statistically designed methods. The losses to various crops in the five regions of the scheme are averaged as under: Wheat 11.1 to 11.9 per cent, Barley 5.8 per cent, Jowar 5.8 to 6.3 per cent, Gram 0.9 per cent, Paddy

4.6 to 5.4 per cent, Groundnut 4.1 to 25.8 per cent, Coconut 5 per cent, Maize 14 per cent and sugarcane 2.2 per cent. Besides these major crops, damages to several other crops were also estimated in field particularly in south India.

Habits

Fair attention was paid by the research workers in the scheme on burrow pattern, number, size, shape and colour of faecal pellets. On the basis of patterns of 10 burrows of each species, Srivastava (1968) found that on an average there are 11.9, 7.2 and 4.2 openings in the burrows of *B. bengalensis*, *T. indica* and *Mus b. booduga*, and are 73.8, 100.5, 35.7 cms. deep respectively. Almost similar results were reported from various other centres. It would have been of interest if such a massive effort of digging about 10,000 burrows in various parts of the country had presented common burrow patterns of various species as has now been done by Barnett & Prakash (1975). Likewise, the extensive work on faecal pellets, paw marks, swimming habits and movements carried out at all the centres could not be used for practical application and yielded conclusion like, "Field observations indicated that the rats migrated from one field to another", or, "Mole rats when caged together started quarrelling with each other" and so on!

Breeding Season

Breeding data collected over 11 years and at 5 centres pointed out that most of the rodents breed all the year round and their litter size varies from 1 to 16, in *B. bengalensis* at Aduthurai, and 3-9 of *R. melstada*. In Uttar Pradesh *M. b. booduga* was found to litter in the months of September, October, February and June and the litter size ranged from 6 to 13. During February to May and July to October each female of *Rattus melstada* produced 1 to

4 litters, each having 1 to 8 young (av. 3.4), (Srivastava 1968). This information appears to have been collected from random samples excavated out of the burrow and probably a monthly catch on a regular pattern was not planned to yield concrete data on the reproduction activity of rodents.

Punjab Agricultural University, Ludhiana

After the termination of the Scheme, the Punjab Agricultural University continued rodent research and a number of students have submitted their M.Sc. and Ph.D. dissertations on Punjab rodents. The major fields of their investigations have been the rodent-crop relationship, their food, breeding habits, population fluctuations, behaviour of *B. bengalensis*, *T. indica*, *R. melta* and *Mus* spp. Bindra & Sagar (1975) have summarised the result of their work carried out during 1964-1972. A useful compendium has been produced by Sood & Guraya (1976). The University continues to be a centre of an ICAR Coordinated Project, a rodent research initiated in 1977.

John's Hopkins University Medical Research & Training Centre, Calcutta

One of the aspects of study at this Centre was rodents and extensive studies were done on *B. bengalensis* in godowns. Though this bandicoot is a field rodent but in the environs of Calcutta and Bombay, it has more or less taken the niche of *Rattus rattus*, and has replaced it almost totally at the former place. Parrack (1966) and Spillett (1968) found that population of *B. bengalensis* in grain storage godowns over an 11 month period was on an average 0.78 per m² of floor space. This appears to be very high figure but Spillett mentioned that these estimates were low. The high population is maintained partly due to their continuous reproductive activity. The preva-

lence of pregnancy for sexually mature females was the highest that has been recorded for a murid population. The mean number of embryos per pregnant female was 6.2. Spillett calculated the mean annual production of young per adult female as 70. The rate of food consumption by bandicoots led the author to calculate food losses due to rats in a typical Calcutta godown to approximately 4,200 kg annually. The Centre was closed subsequent to these studies.

Central Food Technological Research Institute, Mysore

With a major objective to control the rodent pests, the Central Food Technological Research Institute has also carried out valuable work on rodents particularly in the large ratteries, a facility available till recently only to scientists at this Institute. Besides work on food preferences, burrow patterns, behaviour of rodents, population studies, a number of rodenticides have been screened and a few rodent control methodologies have been developed by the scientists of the Institute.

Indian Grain Storage Institute, Hapur

Rodent work at the Grain Storage Research Institute has been carried out in rural environment. Krishnamurthy *et al.* (1967) observed that the population of house rats in the villages around Hapur was on an average 1,057 rats per village, 9.7 per house and 1.3 per person. In improved residential premises, the rat population was only 1.8 per house and 0.34 per person. Later on, however, Krishnamurthy *et al.* (1971) found the density of rats to be 8.5 to 18.5 per house. The authors observed that the average food intake of *R. rattus* varied with their body weight and ranged from 8.98 to 18.69 g wheat per day, *Mus musculus* consumed 2.56 g/day and *B. bengalensis* 50-60 g. The losses of foodgrains in the village were esti-

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mated to range from 1.36 to 3.59 tonnes, average being 2.34 tonnes annually. Another study (Girish *et al.* 1972) calculated that 1 to 3.75 per cent stored foodgrains are lost to rats in city godowns. Besides these studies, work is continuing in the Institute on the efficacy of rodenticides for rodent control. A good compendium has been produced by Pingale *et al.* (1967).

Rodent Control Project, Sidhpur

The work was initiated as an operational research project in the Sidhpur *taluka* of northern Gujarat (80 villages) and one or two villages in every district of the State. Control operation was taken up in residential premises on such a large and successful manner, that the classic work will remain as a demonstration for the entire country if not for the whole world. The villages were maintained at a very low level of rodent population for a long duration (1971-77). Rodent Control Training to State/district/village level workers was another major function of the project. Besides a number of research projects on their population in villages, bait preferences, efficacy of traps and rodenticides, the detailed results are embodied in Ahmedabad Symposium, ably arranged by the project.

Haffkine's Institute, Bombay

In addition to epidemiological studies on Bombay rodents, a great deal of research has been carried out on population change over of species and their control (Deoras 1966).

University of Agricultural Sciences, Bangalore

A department of Vertebrate Biology functioned at the University for five years and it is continued now as a Centre of Coordinated Research Programme on Rodent Control of

the ICAR. The research work here continues on rodent species composition in fields, population dynamics, behaviour, bait preferences, evaluation of rodenticides and operational control methods in field.

Aligarh Muslim University, Aligarh

Most of the research work is continuing on *Rattus rattus* on its food habits, bait preference and bait shyness.

Delhi University, Delhi

After completing work on the Indian gerbil and the squirrels at Bangalore, Dr. M. R. N. Prasad migrated to the Delhi University and along with his colleagues has done intensive work on *F. pennanti* and *Nesokia indica*.

Zoological Survey of India, Calcutta

The Zoological Survey of India can claim the credit for the publication of the Fauna of India series, particularly the two volumes on rodents (Ellerman 1961). Biswas & Tiwari (1966) compiled the latest information on the distribution of rodents in India and Agrawal (1962) published the results of his studies on the skulls of oriental rodents. At present, besides taxonomic work, ecological work on rodents is also continuing in ZSI.

National Institute of Communicable Diseases, Delhi

To elucidate the factors responsible for the persistence of plague in the South India plague focus, the Institute has been conducting studies since 1964 mainly to investigate on the wild rodent plague reservoirs. In addition to epidemiological and serological studies on field rodents, studies have yielded excellent data on the population and breeding biology of *Rattus rattus*, *R. melta*, *Mus platythrix* and *Tatera indica hardwickei* (Chandras 1974).

Sri Venkateswara University, Tirupati

A survey of rodent infested areas revealed *B. bengalensis*, *R. rattus*, *M. booduga*, *R. mel-tada* and *T. indica* as predominant pest species around Tirupati. A detailed ecological work on *M. booduga* was undertaken (Rao 1977). The field mice are solitary burrowers occurring in both dry and wet crop habitats and maintaining a congenial microclimate inside the burrows in all seasons. The preferred food of these mice is seeds of various grasses, roots and leaves of Graminae in summer. A seasonal trend of reproduction from August to February is noted. Behaviour of *M. booduga* and *M. platythrix* has been studied in detail.

Symposia, Summer Institutes and Workshops

At least three internationally attended symposia have taken place which were devoted only to rodents. First one at Calcutta in 1966, arranged by Dwain Parrack of the Johns Hopkins University Centre, the second one at Kanpur by Dr. A. S. Srivastava of the State Department of Entomology in 1968 and lastly at Ahmedabad in 1975, Sidhpur. Proceedings of all the three are still available, though that of the first is hard to get.

ICAR has arranged two Summer Institutes one at UAS, Bangalore and the other at CAZRI, Jodhpur with the main objective of training University, Plant Protection Staff and other Officers for conducting Rodent Research. ICAR has planned to hold workshops regularly to evaluate, coordinate and monitor the rodent research in the country. Latest workshop was held at CAZRI in July, 1978.

In spite of the fact that the history of rodent research in India is fairly old yet, as usual for any scientific field, many obvious questions remain to be answered. We have tried to catalogue them in detail (Barnett & Prakash 1975 and Prakash & Ghosh 1975). There is an urgent need of conducting an ecological survey of field rodents in various habitats of the country. How astonishing is that we just do not know for definite which is the rodent species associated with bamboo flowering in Mizoram? What is the relative abundance of various species in Rayalaseema or Kashmir? What are their population and breeding cycles in various bio-climatic zones? and so on. If we accumulate this knowledge, I am sure we will be able to do a much superior job for the National Programme for Rodent Pest Management.

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